**Template | Unit Enhancement**

***ENGINEERING DESIGN***

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**Background Information**

**Instructional Materials Title: Land and Water**

**Publication Date:**

**Work Group Participants: Michael, Steven, Marion, Julia**

**Date Developed: 8/22/13**

**High Leverage Lesson (Title and Page Number): Dams: How Humans Change the Direction and Flow of Water page 107**

**Rationale**

**This lesson is the only clear engineering lesson in the unit.**

**This lesson has already be adapted to match WA State Science Standards, we are further adapting it to match NGSS as well.**

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***Engineering* Lesson Enhancement**

**Overview**

· **Identification of where within the High Leverage Lesson to insert enhancement**

· **Key instructional strategies and tools needed**

**Criteria and Constraints added to Define the Problem, Optimize is replacing Reflect and Explain, Students will be given opportunity to implement their optimized solutions.**

**Part 1: Lesson Modifications to Lead Up to *Engineering Task***

*Use “Those Darn Squirrels” by Adam Rubin and the worksheet created by Kirk to introduce Criteria and Constraints.*

**Part 2: *Engineering* Learning Sequence**

1. Teacher introduces design problem. “The town of Gaveo experiences flash floods when there are heavy rains. Your design engineering team has been asked to develop a plan to stop this flooding. The town must be set up as outlined in the diagram and cannot be moved. A successful dam will prevent any houses from being washed away or flooded when ½ liter of water is poured through the large whole cup.”
2. Small group/whole class discuss and list Criteria and Constraints on Recording Sheet.
3. Small groups work together to complete steps 2 through 6 on Recording Sheet.
4. Whole class observes each dam as it is tested looking for and recording Failure Points and Design Strengths. (Either as a fish bowl or each dam test can be video recorded) Steps 7 and 8.

Day 2

1. Students conduct real world research on dam design(See Additional Information)
2. Teacher leads whole class discussion to create a common class list of Failure Points and Design Strengths.
3. Small groups use Recording Sheet #2 to design and sketch Optimized Solution.
4. Small groups present their Claims of Merit of their design solution to the whole class.
5. Small groups build their designs, whole class observers each dam test.
6. Students record results of Optimized Solution.

**Part 3-A: Engineering Task**

*Students will use the Recording Sheet to define, develop solutions and optimize their dams. These Recording Sheets can be used to assess success.*

**Part 3-B: Assessment Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 4  Exemplary | 3  Proficient | 2  Developing | 1  Beginning |
| Defining Engineering Problem | States the problem to be solved clearly in terms of the majority of criteria for success, and constraints. | States the problem to be solved including some terms of criteria for success, and constraints. | States the problem to be solved including some terms of criteria for success, or constraints. | Problem stated unclearly and/or missing criteria and constraints. |
| Designing Initial Solutions | Collaborate successfully with a small group to arrive at a consensus and encourages group participation. | Collaborate successfully with a small group to arrive at a consensus. | Collaborate with a small group to arrive at a consensus. At times off topic or disengaged. | Limited to no collaboration and participation. |
| Merit of Final Design | Justify the merit of the design solution based on failure points and design strengths. Sources of data (classmates or research) are cited. | Justify the merit of the design solution based on failure points and design strengths. Incorporated research and/or classmate feedback. | Justify the merit of the design solution based on failure points and design strengths. | Limited justification of design changes. |
| Optimize | Improve the dam solution based on the results of the first test and research, including failure points and design strengths. Clearly including all class feedback. | Improve the dam solution based on the results of the first test and research, including failure points and design strengths. | Improve the dam solution loosely based on the results of the first test and/or research. | Dam redesign does not reflect any research or use of feedback. |

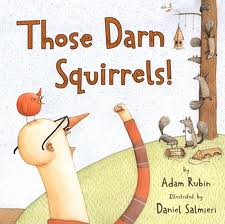
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**Additional Information**

NOTES

· Information that will be useful when teaching this lesson

* Resources that will be useful
* Links to videos of dams in action:  
    
  [http://youtu.be/fqceTkveWTo](https://edumail.seattleschools.org/owa/redir.aspx?C=8qVUC5smPkOr2Y3EepMmnUiEhXwSc9AI3n_MnWS6GPuJeF2u230rcCY1IjoyJnHgHkikWjgC_dY.&URL=http%3a%2f%2fyoutu.be%2ffqceTkveWTo)    
    
  This link shows a basic design for an earthen dam.  It's from India!  Pretty short, super simple.  
    
  [http://youtu.be/bWEWVw7TGk4](https://edumail.seattleschools.org/owa/redir.aspx?C=8qVUC5smPkOr2Y3EepMmnUiEhXwSc9AI3n_MnWS6GPuJeF2u230rcCY1IjoyJnHgHkikWjgC_dY.&URL=http%3a%2f%2fyoutu.be%2fbWEWVw7TGk4)  
    
  This link shows a dam model in action with no spillway.  This could be used to clearly illustrate the need for some way of releasing \*some\* of the water to optimize the dam.  In other words, this would be an example of what \*not\* to do. : )  
    
  [http://youtu.be/3MdB\_s6KhwA](https://edumail.seattleschools.org/owa/redir.aspx?C=8qVUC5smPkOr2Y3EepMmnUiEhXwSc9AI3n_MnWS6GPuJeF2u230rcCY1IjoyJnHgHkikWjgC_dY.&URL=http%3a%2f%2fyoutu.be%2f3MdB_s6KhwA)    
    
  An interesting video showing the devastating failure of the St. Francis Dam in Southern California.  600 people died. : ( This may be worth showing to illustrate that even professionally engineered dams occasionally fail.  
    
  [http://youtu.be/NcZIkComxlA](https://edumail.seattleschools.org/owa/redir.aspx?C=8qVUC5smPkOr2Y3EepMmnUiEhXwSc9AI3n_MnWS6GPuJeF2u230rcCY1IjoyJnHgHkikWjgC_dY.&URL=http%3a%2f%2fyoutu.be%2fNcZIkComxlA)  
    
  Short video of homemade dam, showing a small spillway.  This could be used to reinforce the idea of a spillway.  
    
  [http://youtu.be/KXZV7rmuUMI](https://edumail.seattleschools.org/owa/redir.aspx?C=8qVUC5smPkOr2Y3EepMmnUiEhXwSc9AI3n_MnWS6GPuJeF2u230rcCY1IjoyJnHgHkikWjgC_dY.&URL=http%3a%2f%2fyoutu.be%2fKXZV7rmuUMI)  
    
  Cute video of homemade dam with Lego people!  The dam fails because of pressure.  Subtitles are in German, but they are not needed to make the video worthwhile.

Those Darn Squirrels Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Identify places in the story where the squirrels engage

in the three components of Engineering Design:

1. **Define the problem**
2. **Designing solutions to engineering problems**
3. **Optimizing the design solution**

|  |
| --- |
| 1. **Define the problem** the squirrels are attempting to solve:   Identify **constraints** (limits):  Identify **criteria** for success (goals): |
| 1. IMG_0255.JPG**Designing solutions to engineering problems** begins with generating a number of different possible solutions, then considering each to see which ones best meet the criteria and constraints of the problem.   Brainstorm some other **solutions** than the one pictured here:   |  |  |  | | --- | --- | --- | | Solutions | How does it meet criteria (goals)? | How does it meet constraints (limits)? | |  |  |  | |  |  |  | |
| 1. **Optimizing the design solution** involves a process in which solutions are tested and changes are made to improve the design. We know that the solution pictured in #2 did not solve the problem. What might the squirrels do to refine their solution? |

Appendix

Dam Recording Sheet #2: Optimized Solution

Group: Date:

Names:

1. Review the results of your first design solution.

1. What design strengths do you want to keep in your ***optimized solution***?
2. What can you do to reengineer (fix) your failure points? Use what you’ve learned from your failures and your research.

2. Draw a map of the stream table including your new design solution. Make sure to label your diagram.

3. Make a ***claim*** about your design solution: Tell me why you chose your design solution and what you think will happen when it’s tested.

4. Build your design solution:

a. Set up your stream table as you have in other lessons.

b. Use a spoon to carve the Gaveo River in your stream table.

c. Look at the map. Place the plastic cubes in your stream table to represent the town of Gaveo. Make certain they are in the same place as the previous test in order to maintain a fair test.

4. Test your design solution.

5. Record you results: Did your optimized solutions improve the effectiveness of the dam?